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Italian Association of Aeronautics and Astronautics
XXV International Congress
9-12 September 2019 | Rome, Italy

DESIGN OPTIMIZATION OF A VLA COMPOSITE WING

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ABSTRACT

The purpose of this work is to develop an efficient methodology to optimize the structure of the composite wing of the Dardo Aspect, a wet-laminate full composite very-light aeroplane (VLA) designed and built by CFM Air.
First, results for static, dynamic, buckling and flutter analysis are discussed. The FEM model and all the analysis are carried out in Nastran. In optimization analysis the key issues are represented by the objective function, the design variables and the constraints. In the present work the objective function is represented by the minimization of the total weight of the wing. When it comes to laminate composite materials, it could be possible to directly manipulate the stacking sequence, potentially obtaining a too high number of design variables, affecting the runtime of the code. Hence, in order to minimize the number of parameters, the mechanical behaviour of the laminate is represented, through homogenization and parametrization, by the lamination parameters (LP). Each panel is represented by a maximum of 12 lamination parameters and the thickness, limiting the number of the total design variables. In this case, due to the use of LP it is necessary to take into account some feasibility constraint, that will ensure that the results obtained correspond to a feasible stacking sequence. During the optimization process, it has been decided to constraint the first buckling eigenvalue at the ultimate loading of the wing. Furthermore, also some manufacturing constraint are considered. In order to perform the optimization analysis, it has been necessary to correctly readapt the FEM model, dividing each component in different patches to obtain a more accurate solution.
The optimization analysis has been carried out on the front spar patches, obtaining new LP and thicknesses which ensure a reduction of the spar weight of 36%.

REFERENCES

[1] Z. Gurdal, R.T. Haftka, P. Hajela, *Design and optimization of laminated composite materials*, Wiley, 1999.

[2] Gustavo H. C. Silva, Alex Pereira do Prado, Pedro Higino Cabral, Roeland De Breuker, and Johannes K. S. Dillinger. *Tailoring of a Composite Regional Jet Wing Using the Slice and Swap Method*, Journal of Aircraft, 1–15.

[3] S. Setoodeh, M. Abdalla, and Z. Gurdal. *Approximate Feasible Regions for Lamination Parameters*, 11th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference, Multidisciplinary Analysis Optimization Conferences, September 2006, Portsmouth, Virginia.